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# PROPERTIES OF CONCRETE WITH COCONUT SHELLS AS AGGREGATE REPLACEMENT

Mr.M.Ebi Joseph
BE,Civil Engineering Final Year,PET Engineering,College,Vallioor
Tirunelveli,Tamil Nadu,India.

## ABSTRACT

Properties of concrete with coconut shells (CS) as aggregate replacement were studied. control concrete with 10 -20% course aggregate replacement with CS were made. Two mixes with CS and fly ash were also made to investigate fly ash effects on CS replaced concretes. Constant water to cementitious ratio of 0.6 was maintained for all the concretes. Properties like compressive strength, split tensile strength, water absorption and moisture migration were investigated in the laboratory. The results showed that, density of the concretes decreases with increase in CS percent. Workability decreased with increase in CS replacement. Compressive and split tensile strengths of concretes than control concrete. Course aggregate replacement with equivalent weight of fly ash had no influence when compared with properties of corresponding CS replaced concrete.

## INTRODUCTION

Infrastructure development across the world created demand for construction materials. Concrete is the premier civil engineering construction material. Concrete manufacturing involve consumption of ingredients like cement, aggregates, water and admixture.

Thus, the aim of this work is to provide more data on the strengths of coconut shell concretes at different coconut shells (CS) replacements and study the transport properties of concrete with CS as coarse aggregate replacement. Furthermore, in this study, the effect of fly ash as cement replacement and aggregate replacement on properties of the CS replaced concrete was also investigated.

## EXPERIMENTAL INVESTIGATIONS

## MATERIALS

The constituent materials used in this investigation were procured from local sources. Ordinary Portland cement of C53 grade conforming to both the requirements. Fly ash used in the is investigation was procured from local suppliers. Chemical composition of the materials is presented in Table 1 along with specific gravities of the materials. Normal aggregate, that is, crushed blue granite of maximum size 20mm was used as course aggregate. Well graded river sand passing through 4.75 mm was used as fine aggregate. The specific gravities of coarse and fine aggregates were 2.65 and 2.63 respectively. Coconut shells which were

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already broken into two pieces were collected from local temple; air dried for five days approximately at the temperature of 25 to 30°C; removed fibre and hush on dried shells; further broken the shells into small chips manually using hammer and sieved through 12mm sieve. The material passed through 12mm sieve was used to replace coarse aggregate with CS.

## MIX PROPORTIONS

In order to investigate properties of CS concretes, for using M 25 proportions. Control mix (M1) that is, without CS was made. Coarse aggregate was then replaced with CS in 10 15 20 percentages to study effect of CS replacement.


*Figure1 Processing of coconut shells: (i) air drying at 25-30°C, (ii) breaking coconut shells and (iii) sieved coconut shells through 12mm sieve.*

## TEST PROGRAM

The main objective of the present investigation was to study the performance of CS concretes in terms of strength and transport properties with normal water curing and with no chemical admixtures in the mixes. Performance of the concretes was assessed through; compressive strength, spilt tensile strength, water absorption and sorption. The specimens were tested for compression and spilt tensile strengths at 1, 7 and 28 days. The strengths were obtained by considering the average of two replicate specimens.

## COMPRESSIVE STRENGTH TEST

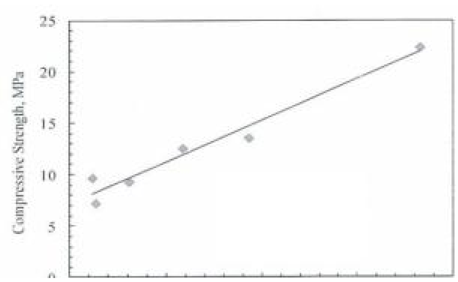
The compressive loading tests on concretes were conducted on a compression testing machine of capacity 2000 kN. For the compressive strength test, a loading rate of 2.5kN/s was applied. The test was conducted on 150mm cube specimens at 1, 7 and 28 days.

## PROPERTIES OF FRESH CONCRETE

The fresh state performance of the CS concretes was comparable with control concrete. The concretes had low slump the slump values of the concretes were between 20-26mm. The slump decreased with increase in CS percentage,

## COMPRESSIVE STRENGTH

Control concrete gained 31 percent and 50 percent over its 28 day compressive strength at one day and 7 days of cuing respectively, Strength of the CS concrete increased 24-42 percent at one day and 38-84 percent after 7 day of cuing than is corresponding 28 day strengths repectively. The observations suggests that as VS percentage increased the 7 day strength gain also increased with corresponding 28 day cuing strength. The CS concretes, especially 15% (M3) and 20% (M4) replacement level the concretes failed to maintain same strength gain, which had first 7 days of curing.



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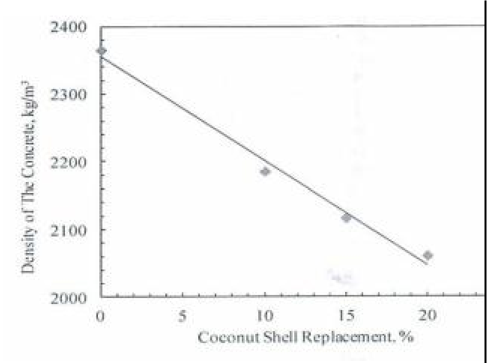


## FURTHER DISCUSSION

There may be a possibility to increase strength of CS replaced concrete. The coconut shells need to be cleaned thoroughly and make them free from fibre and husk on the surface. Size of the CS particles should be nearly equal to the thickness of the CS particle with decreased size may avoid problems associated with shape and thus improve boding between the aggregate particles and cement paste, Increased bond between the particles my lead to higher strength. On the other hand, reduced particle size may increase surface area and may lead to increased water demand and may cause strength reduction. In the present investigation the free water to cementitious ratio was 0.6. However, with the help of water reducing admixtures, if water to cementitious material ratio can be reduced, then, if may be possible to increase strength of CS replaced concretes. Further investigation is clearly needed to asses particle size effect and effect of water cementitious ratio on CS concrete. Christo Ananth et al. [3] proposed a system, this fully automatic vehicle is equipped by micro controller, motor driving mechanism and battery. The power stored in the battery is used to drive the DC motor that causes the movement to AGV. The speed of rotation of DC motor i.e., velocity of AGV is controlled by the microprocessor controller. This is an era of automation where it is broadly defined as replacement of manual effort by mechanical power in all degrees of automation. The operation remains an essential part of the system although with changing demands on physical input as the degree of mechanization is increased.

## RESULTS AND DISCUSSION

A comprehensive summary of the strength properties of normal and CS concretes are presented in Table 4 CS replaced concretes.

## CONCLUSIONS

Results of experiments on compressive strength, and CS replaced concretes have been presented with those of control concrete. the data shows the CS aggregate can be used in place of normal aggregate, however, performance of CS aggregate concrete is little lower than normal aggregate concrete. The main points of this study are:

1. Addition of CS decrease workability and addition of fly ash either as cement replacement or aggregate replacement increase workability of CS concrete. Increase in CS percentage decreased densities of to concretes.

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2. The results demonstrated that, irrespective of CS percentage replacement there was good relationship between compressive strength and spilt tensile strength. The equation proposed by Raphel, 1984 (19) for normal concrete was over predicting at lower strengths for CS concretes.

**Table 1 Chemical composition and specific gravity of the materials**

| | Cement | Fly ash |
|---|---|---|
| **Chemical Composition (%)** | | |
| $SiO_2$ | 21.8 | 58.3 |
| $Al_2O_3$ | 6.6 | 31.7 |
| $Fe_2O_3$ | 4.1 | 5.9 |
| CaO | 60.1 | 2 |
| MgO | 2.1 | 0.1 |
| $Na_2O$ | 0.4 | 0.8 |
| $K_2O$ | 0.4 | 0.8 |
| $So_3$ | 2.2 | 0.2 |
| Others | -- | -- |
| LOI | 2.4 | 0.3 |
| Specific gravity | 3.15 | 2.06 |

**TABLE 2 AGGRAGATE GRADING**

| Seive size | Cumluative percentage passing | | | |
|---|---|---|---|---|
| | 20mm | 12mm | CS | Sand |
| 25 | 100 | - | - | - |
| 19 | 95 | - | - | - |
| 12.5 | 60 | 97.5 | 98.5 | - |
| 9.5 | 30 | 82.5 | 62.5 | - |
| 4.75 | 3.5 | 7.5 | 16 | 99 |
| 2.36 | - | 2.5 | 7 | 88 |
| 1.18 | - | - | - | 55 |
| 0.6 | - | - | - | 17 |
| 0.3 | - | - | - | 3 |
| 0.15 | - | - | - | 0.5 |

**TABLE 3 MIXTURE PROPORTIONS**

| concrete name | Cement $kg/m^3$ | f. $kg/m^3$ | CA $kg/m^3$ | FA. kg/m | CS $kg/m^3$ | w/cm |
|---|---|---|---|---|---|---|
| M1 | 300 | 0 | 1170 | 750 | 0 | 0.6 |
| M2 | 300 | 0 | 1053 | 750 | 117 | 0.6 |
| M3 | 300 | 0 | 994.5 | 750 | 175.5 | 0.6 |
| M4 | 300 | 0 | 936 | 750 | 234 | 0.6 |

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| | | | | | | |
|---|---|---|---|---|---|---|
| M5 | 225 | 75 | 936 | 750 | 234 | 0.6 |
| M6 | 300 | 96 | 813.12 | 750 | 203.28 | 0.6 |

CS – coconutshells, fly ash, CA – coarse aggregate, FA-fine aggregate,cm-eementitious materials (c+f)

**TABLE -4 STRENGTH PROPERTIES OF NORMAL AND CS CONCRETES**

| Mix name | Slump mm | Density kg/m$^3$ | Compressive Strength, MPa | | |
|---|---|---|---|---|---|
| | | | 1day | 7day | 28day |
| M1 | 25 | 2365 | 6.84 | 11.11 | 22.33 |
| M2 | 23 | 2186 | 3.2 | 5.16 | 13.56 |
| M3 | 22 | 2117 | 3.56 | 7.29 | 12.56 |
| M4 | 20 | 2061 | 3.91 | 7.82 | 9.33 |
| M5 | 23 | 2027 | 2.22 | 3.47 | 7.22 |
| M6 | 26 | 2023 | 3.40 | 5.56 | 9.67 |

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